massive rock not susceptible of being quarried. They were therefore not migrant features that receded rapidly headward during the process of glaciation, in the manner implied by certain hypotheses that have been advanced in explanation of the development of glacial stairways. They were essentially fixed features definitely related to the structure of the rock. The canyon steps, accordingly, are conceived to have been produced by selective glacial quarrying. Each tread is essentially a basin quarried out in jointed rock; each edge is essentially a residual obstruction of unquarriable rock, smoothed on the upstream side by abrasion, steepened on the downstream side by the removal of jointed rock. Glacial excavation proceeds with greatest vigor at the head of each tread, because there the ice exerts the greatest force in consequence of its plunge from the step above and accumulates to greatest thickness.

This explains how the steeply rising preglacial floor of the Yosemite Valley was replaced by a nearly level, basined rock floor, and why the depth of excavation is three times as great at the head of the valley as at its lower end. The ice descended into the head of the valley not merely by way of the giant stairway from whose steps the Vernal and Nevada Falls now leap, but during the culminating phases of glaciation it also plunged from the lofty platform at the southwest base of Half Dome in the form of a mighty glacial cataract. The deep, walled-in heads of the Little Yosemite and Tenaya Canyon similarly were excavated mainly by great cataracts of ice.

Structure control also has determined the level of each step. The high level of the Little Yosemite was determined by the height of the body of massive granite that forms the upper step of the giant stairway. The absence of a step at the mouth of Tenaya Canyon, on the other hand, is explained by the fact that glacial excavation there was facilitated by the presence of a belt of fractured rock.

The detailed sculpture of the walls of the Yosemite Valley is likewise a function of the structure of its rocks, the actions of the weathering processes having been sharply controlled by local variations in the jointing. Vertical master joints have determined the profile and orientation of most of the great cliff faces, including the sheer precipices over which the waterfalls leap. Northeasterly and northwesterly master joints account for much of the faceted sculpture. Easterly master joints have controlled the trend of the great precipice of the upper Yosemite Fall and of the famous cliff at Glacier Point. Oblique joint planes dominate the sculpture of the Three Brothers and of many lesser spurs. Prevailingly sparse jointing in the more siliceous rocks explains the predominance of massive rock forms. Narrow zones of intense fracturing, on the other hand, have given rise to deep recesses, even in places where no drainage descends or formerly descended from the uplands. All the notches, gulches, and alcoves in the vicinity of the waterfalls at the mouths of hanging valleys and on the steps of the giant stairway are carved along fracture zones. Only a few have been produced in the manner explained by Branner, by torrents that flowed along the margins of the glaciers.

The domes of the Yosemite region have been evolved from giant monoliths by long-continued exfoliation due to expansion of the granite, presumably in consequence of relief from load by denudation. The irregularities of their curvature still betray to some extent the trend of the master fractures that originally bounded the monoliths. Half Dome is exceptional in that its sheer northwest side has been exposed only recently by glacial plucking and therefore still retains the plane form which it has inherited from a sheeted structure with northeasterly trend. Exfoliation here and in certain other localities is producing essentially plane sheets. On cliffs ground concave by the glaciers, notably on the step above the Vernal Fall, it produces concave shells.

Examination of the débris piles at the bases of the cliffs dispels the belief of some of the earlier observers that 90 per cent of the material was precipitated by a single great postglacial earthquake. There is evidence that in addition to many small rock falls there have occurred several great rock avalanches, and that the intervals between those avalanches were of sufficient length to permit forests to grow up repeatedly on the talus slopes. Earthquake action appears to be indicated most definitely by far-flung hummocky masses of débris that contrast with the sloping taluses and that must have been precipitated from the cliff fronts in their entirety.

The greatest postglacial change in the appearance of the Yosemite region was brought about by the filling of the glacial-lake basins with stream-borne sediment. The level sandy floors of the Yosemite and the Little Yosemite and the successive treads of Tenaya Canyon all replace glacial lakes. The floor of the Yosemite Valley does not, however, indicate the exact level at which the water of ancient Lake Yosemite stood. It is a flood plain of the Merced River cut about 15 feet below the old lake level, which is indicated by terraces. Mirror Lake is not a remnant of a glacial lake but was impounded by great rock avalanches that fell from the cliffs at the mouth of Tenaya Canyon, presumably as the result of an earthquake, some time after the glacial epoch.

An attempt is made in this volume to set forth these facts and interpretations in language intelligible to the general reader as well as to the scientist. The Yosemite Valley is treated not by itself but in its setting, as an erosional feature of the Sierra Nevada that came into being and was evolved by successive stages in consequence of certain epochal events in the orogenic history and in the glaciation of the range.

In the appendix the nature and significance of the remarkable complex of igneous intrusions into which the Yosemite Valley is hewn are outlined by Frank C. Calkins. A geologic map of the Yosemite region, the upper Merced Basin, and the upper Tuolumne Basin shows the complex in its relations to the vast intrusive masses that occupy the surrounding parts of the Sierra Nevada. The rocks described range from nearly white alaskite to nearly black hornblende gabbro, yet a strong family resemblance is visible in all. Two distinct series of intrusions are recognized—the biotite granite series of the Yosemite Valley and the Tuolumne intrusive series—and in addition there are several kinds of rock not definitely assignable to either of these series.

INTRODUCTION

"The incomparable valley" the Yosemite has been called by those who admire and love it—and rightly so, for where can be found another valley of such distinctive beauty, such impressive grandeur, such captivating charm? Yet hardly less appropriate, from another point of view, would be the title "valley of mystery," for surely no other valley has aroused more curiosity among scientists or laymen or given rise to more speculation and discussion as to the secret of its origin. So extraordinary is the appearance of the Yosemite Valley, with its sheer, monumental cliffs and massive, rounded domes, its lofty, swaying waterfalls and verdant, parklike floor, that it seems in a class by itself, created in some special, unusual way, apart from all other valleys and canyons. No person of intelligence, it is safe to say, ever beheld the Yosemite Valley who did not instantly wonder by what strange process it was formed and through what fortuitous circumstances it became endowed with such surpassing beauty and loveliness.